INSTRUCTION MANUAL

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OSCILLATOR - AMPLIFIER
MODEL 855 - A1

ELECTRO - MEASUREMENTS, INC.

PORTLAND 1, OREGON

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ELECTRO-MEASUREMENTS, INC.

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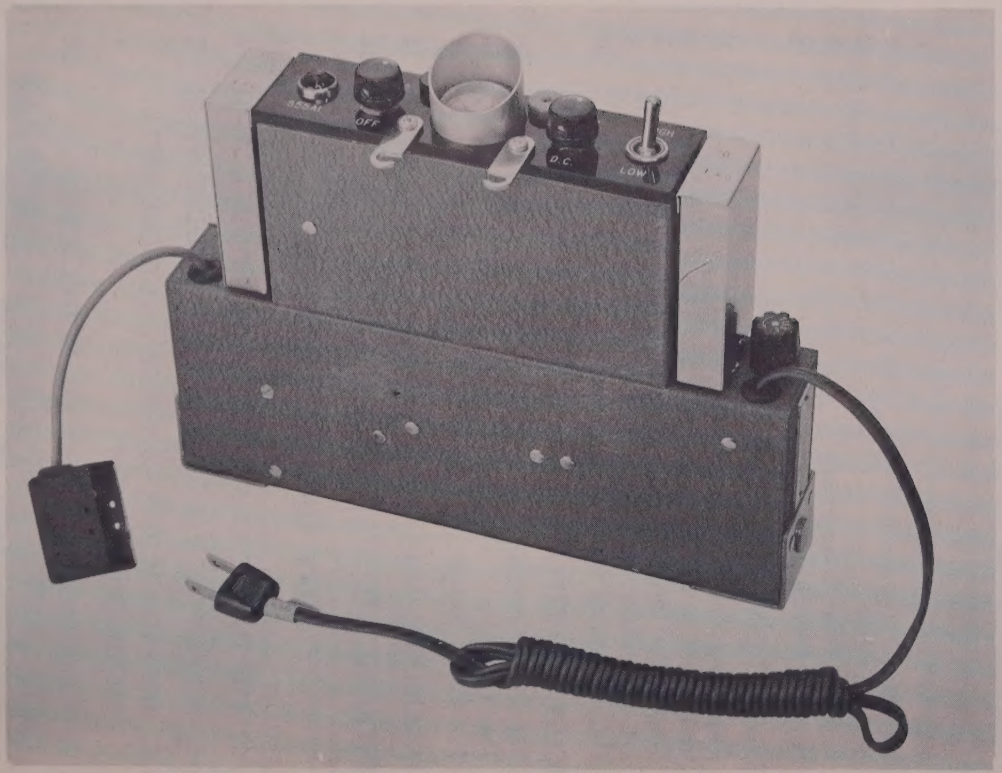


Figure 1. *Model 855-A1 Amplifier-Oscillator*

OSCILLATOR-AMPLIFIER
MODEL 855-A1

GENERAL DESCRIPTION

The ESI Model 855-A1 Oscillator-Amplifier is a compact AC line operated instrument designed to extend the overall range and usefulness of the ESI Model 250 Series Impedance Bridge. The unit is self-contained and has been engineered to fit in the bridge battery compartment. A vacuum tube null amplifier with adjustable gain from zero to 65 decibels and a visual null indicator greatly increases the precision of balance which can be achieved with the ESI Impedance Bridge. Controlled generator output voltage at any specified frequency within the 100 to 10,000 cycle range is obtained from a vacuum tube oscillator through the use of frequency selecting plug-in networks. A single power supply provides all the necessary operating voltages for the circuits mentioned above plus a source of high and low impedance DC voltages for use when making DC resistance measurements with the bridge. The accessory unit eliminates the need for bridge batteries and headphones. For a general understanding of the basic circuits employed in this instrument, refer to the block diagram shown as Figure 2. A more detailed explanation of the circuitry appears on page 10 under CIRCUIT DESCRIPTION.

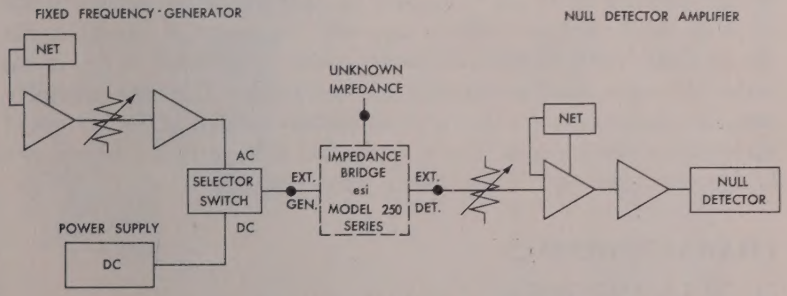


Figure 2. *Simplified block diagram of Model 855-A1 Oscillator-Amplifier.*

DESCRIPTION OF MAJOR COMPONENTS

(a) FRONT PANEL. When the Oscillator-Amplifier is used with the ESI Impedance Bridge, it is mounted in the bridge battery com-

partment. Under these conditions, the only exposed portion of the instrument is the front panel on which all the operating controls are mounted. Referring to Figure 3, the operating controls consist of: a combined ON-OFF switch and amplifier gain potentiometer—the switch is actuated when the amplifier gain knob (AMP) is turned counterclockwise to the OFF position. An ON-OFF indicator lamp is located to the left of this control. In the center of the panel is an electron-ray null indicator, two tip-jack terminals which are located above the null indicator and connect to the null amplifier output (the jacks are color coded red and black—the red one is coupled to the output of the null amplifier and the black one is tied to ground), and the AC oscillator generator output terminals which are mounted immediately below the null indicator. The voltage appearing at these terminals can be adjusted from zero to approximately 12 volts maximum with the control knob (OSC) located on the right hand portion of the panel. Turning this control to the extreme left position reduces the oscillator voltage to zero and actuates a switch which applies DC voltage to the bridge battery input terminals (DC position). When the (OSC) control is in the DC position, the electron-ray tube goes off indicating that the galvanometer should now be used for null indication. The toggle switch located to the right of the (OSC) knob provides for the selection of HIGH or LOW impedance DC voltage.

(b) ADDITIONAL EXTERNAL COMPONENTS. A recess has been built into the instrument cabinet on each side of the front panel. The recess to the left houses the plug-in network used for obtaining proper frequency response characteristics for the null amplifier and the null amplifier input cable with plug for attaching to the impedance bridge detector terminals. The plug-in network in the recess to the right of the front panel selects any one frequency of operation for the oscillator between 100 and 10,000 cycles. Also found in this recess is the AC power cord and the AC line fuse holder. The only remaining external components are the terminal buttons located at the bottom of each side of the cabinet. These apply DC voltage to the impedance bridge when making DC resistance measurements.

CHARACTERISTICS

(a) NULL AMPLIFIER

1. *Frequency Selective Null Amplifier.* Plug-in networks provide peaked amplifier response at any desired frequency between 100 and 10,000 cycles. The unit is normally supplied with a standard 1,000 cycle network. Attenuation of the second harmonic response is approximately 20 decibels when selective networks are employed. Flat amplifier frequency response is available by removing the plug-in network.

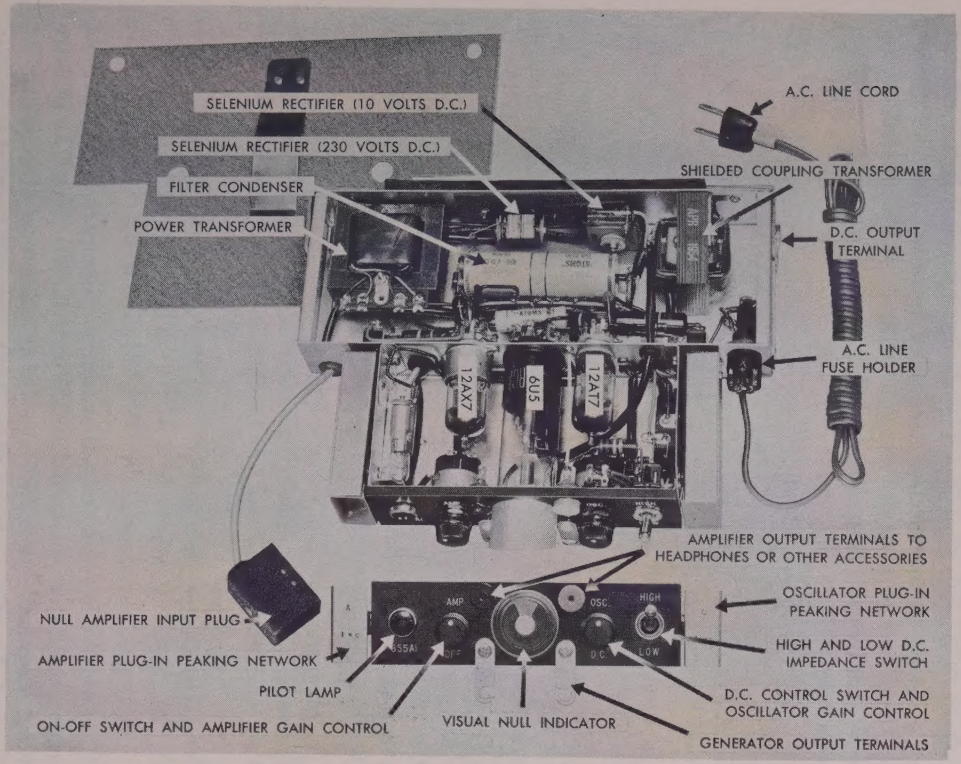


Figure 3. *Identification of panel controls and major components.*

2. *Continuously Variable Amplifier Gain.* The amplifier gain is adjustable from zero to approximately 65 decibels.

3. *Visual Null Indicator.* An electron-ray tube operating from the amplifier output provides a convenient visual null indicator for AC impedance measurements.

(b) OSCILLATOR

1. *Multi-Frequency Oscillator.* Plug-in networks allow the oscillator to be operated at any desired frequency between 100 and 10,000 cycles. The unit is normally supplied with a standard 1,000 cycle network. Additional tuning units for other frequencies can be supplied as accessories.

2. *Good Frequency Stability and Waveform.* The oscillator frequency is adjusted to ± 1% of the normal operating frequency. The waveform of the output signal is considerably better than that of the internal bridge generator which it replaces.

3. *Low Harmonic Output.* With the oscillator adjusted for maximum output, less than 2% harmonic voltage is present.

4. *Continuously Adjustable Oscillator Output.* The generator output is adjustable up to a maximum of approximately 15 volts with an internal impedance of 600 ohms.

5. *Special Coupling Transformer.* A transformer with a carefully shielded and isolated secondary is employed to couple the oscillator to the bridge. This transformer minimizes errors caused by stray capacitances to ground normally introduced by an external generator.

(c) POWER SUPPLY

1. *High and Low DC Voltage Sources.* For making DC resistance measurements this instrument provides for good null sensitivity by making available a high and low impedance DC voltage source.

Ratings	*High*	*Low*
Open circuit voltage - -	250 volts	10 volts
Maximum current - - -	10 ma.	150 ma.
Internal Impedance - -	25K ohms	15 ohms

2. *Input Voltage.* A dual transformer primary winding permits operation at 105-125 volts or at 210-250 volts, 50-60 cycles. The primary winding leads are terminated on a bakelite terminal tie-strip. In the instrument the color code for these leads from left to right is yellow-blue-red-green. For 105-125 volt operation, as supplied by the factory, the yellow and blue leads and the red and green leads are strapped together. To convert to 210-250 volt operation, these straps should be removed and the blue and red leads should be strapped.

3. *Power Input.* 10 watts.

(d) VACUUM TUBE COMPLEMENT

1. 12AX7 (Twin Triode Null Amplifier).
2. 6U5 (Electron-Ray Visual Null Indicator).
3. 12AT7 (Twin Triode Oscillator-Amplifier).

(e) PHYSICAL SPECIFICATIONS

1. *Dimensions.* All components are mounted on a single chassis with maximum dimensions of 1½ inches wide by 10¾ inches long and 7½ inches deep.

2. *Weight.* Net, 4 pounds. Shipping, 8 pounds.

OPERATING INSTRUCTIONS

(a) UNPACKING AND INSPECTING THE INSTRUMENT

The ESI Model 855-A1 Oscillator-Amplifier is shipped from the factory with all tubes in place and ready for operation from a 115 volt AC line. Upon receipt the instrument should be carefully inspected for any apparent damage received while in transit.

(b) INSTALLATION IN THE ESI MODEL 250 IMPEDANCE BRIDGE

1. Insert the Amplifier-Oscillator in the Impedance Bridge battery compartment after removing the fibre battery cartridge.

2. Connect the oscillator output terminals to the bridge external generator (EXT GEN) binding posts and connect the null amplifier plug to the bridge external detector (EXT DET) binding posts.

(c) PLACING THE MODEL 855-A1 IN OPERATION

1. Plug line cord into appropriate 115/230 volt 50 to 60 cycle AC power receptacle.

2. To turn unit on, rotate the amplifier gain control (AMP) clockwise.

3. Allow 30 seconds for warm-up time. A bright green target should be seen on the null indicator providing the DC impedance selecting switch is set on the HIGH position and the oscillator gain control (OSC) is not on the DC position.

(d) MAKING AC IMPEDANCE MEASUREMENTS USING ESI IMPEDANCE BRIDGE MODEL 250 SERIES

1. The bridge GENERATOR SWITCH should be set on the INTERNAL POWER OFF position.

2. The bridge DETECTOR SWITCH should be set on the EXTERNAL DETECTOR position.

3. After energizing the instrument as outlined above, adjust the oscillator gain control (OSC) to provide adequate generator voltage for bridge operation.

4. Adjust the null amplifier gain control (AMP) until adequate gain for proper bridge operation is available.

5. Balance the impedance bridge as outlined in the bridge instruction manual. Maximum opening of the electron-ray visual indicator "eye" indicates optimum null.

(e) MAKING DC RESISTANCE MEASUREMENTS WITH ESI BRIDGE MODEL 250 SERIES

1. The bridge GENERATOR SWITCH should be set on the 6 VOLTS DC position.

2. The bridge DETECTOR SWITCH should be set on SHUNTED METER position.

3. Set the oscillator gain control (OSC) on *DC* position and the IMPEDANCE SELECTING SWITCH on the appropriate HIGH or LOW position. Use the HIGH position for all measurements of resistance except for resistance of less than 100 ohms. (Note: No damage is done to the bridge or the power supply if this switch is in the wrong position).

4. Energize the instrument as outlined above. Make subsequent measurements in accordance with the bridge instruction manual using the bridge galvanometer as a null indicator.

CIRCUIT DESCRIPTION

(a) THE NULL AMPLIFIER

The ESI Model 855-A1 Oscillator - Amplifier makes use of high-mu twin triode (V-1) as a null amplifier. The high impedance input receives the signal to be amplified from the external detector binding post on the ESI impedance bridge by means of the special terminal plug provided. The signal is then applied to the grid of the first triode by means of the slider arm on the amplifier gain control potentiometer (R-36). Plate output signal is coupled to the grid of another triode by C-6 for a second stage of amplification. The output from the amplifier at this point has flat frequency response characteristics between the intended frequencies of operation (100 to 10,000 cycles). However, a special network tuned to the frequency of operation can be plugged in between the grid and plate of the second triode for peaked amplifier signal. Output signal from this stage is made available to the pin jacks on the front panel and is also applied to the grid of V-2, the electron-ray visual null indicator tube.

(b) THE OSCILLATOR

A second high-mu triode (V-3) has been used as an oscillator-amplifier tube. The first triode, the oscillator section, incorporates a resistance-capacitance tuned circuit utilizing a plug-in network. This

network controls the oscillator frequency and maintains it to within ± 1%. Normally, a 1,000 cycle unit is supplied by the factory. Special networks at any frequency between 100 and 10,000 cycles can be provided on special order or can be procured as accessory equipment. The oscillator output is applied to the grid of the second triode by means of C-13, R-5, and the variable output gain control, R-50. Plate voltage for this second stage of amplification is applied through the primary of a special coupling transformer (T-2) which has been designed with a carefully shielded and isolated secondary for the purpose of minimizing errors normally caused by stray capacitances to ground. The secondary of this transformer is connected directly to two movable terminals located on the front panel below the visual null amplifier.

(c) THE POWER SUPPLY

A single power transformer (T-1) supplies all the necessary power for the instrument. The primary of this transformer has a dual winding so that either 115 or 230 volts from a 50 to 60 cycle power source can be utilized for operating the unit. The ON-OFF power switch for the instrument is located between the transformer primary and the line cord as well as a 1 ampere fuse which affords the instrument overall protection from possible damage due to component failure. The secondary of the transformer provides outputs of 6.3 volts at 1.05 amperes for the vacuum tube filaments and panel lamp, 230 volts at 20 milliamperes and 10 volts at 150 milliamperes. The 230 volt secondary voltage is converted to DC for use as vacuum tube plate voltage by means of two selenium rectifiers (CR-1 and CR-2) each rated at 130 volts at 20 milliamperes and is filtered by two R-C "L" type networks composed of R-55, C-15 and R-54, C-14. This voltage is applied to the DC bridge battery input terminals for making DC resistance measurements when the DC impedance selecting toggle switch (S-10) is in the HIGH position. Under these conditions, R-52 provides sufficient resistance to limit the output current so that neither the bridge components or the selenium rectifiers (CR-1 and CR-2) can be damaged. When making DC measurements of small resistances, 10 volts DC can be applied to the bridge by means of S-10. This voltage is provided by the 10 volt secondary winding on T-1 and the full wave selenium rectifier (CR-3). Notice that this DC power supply has been designed with a maximum insulation resistance to ground, a feature which is not available in most supplies. The importance of this is that any stray resistance appearing across the power source to ground will also appear across the impedance bridge arms to ground and will cause erroneous readings.

MAINTENANCE AND ADJUSTMENTS

(a) MAINTENANCE

The ESI Model 855-A1 Oscillator-Amplifier requires a minimum of upkeep under normal operating conditions. Most of the components used in the unit are carried by all major distributors of electronic parts and can be readily replaced by removing the detachable side of the metal instrument case. The component specifications together with the circuit schematic are provided in this booklet, Figure 4. Non-standard components, such as the transformers, can be obtained from the ESI factory at current net prices. Normally trouble will only occur in one section of the unit at a time, thus any problem can usually be localized to the null amplifier, visual null-detector, oscillator-amplifier, or power supply section (refer to the TROUBLE SHOOTING CHART, Table 1 and the block diagram, Figure 2).

(b) ADJUSTMENTS

The only adjustment required by the Model 855-A1 Oscillator-Amplifier is the setting of the oscillator frequency to within ± 1%. A trimmer (C-23) located in the oscillator plug-in network is used for making this adjustment. In the 1,000 cycle unit, this trimmer will normally vary the oscillator frequency over a 3% range. Readjustment of this trimmer is seldom required after initial setting at the factory. Should readjustment be required, the trimmer is easily reached by removing the metal shield from around the oscillator plug-in network. Prior to making an adjustment, the instrument should be energized and allowed to reach a stable operating temperature.

ADDITIONAL APPLICATIONS

The use of the ESI Model 855-A1 instrument is not limited to the ESI Model 250 Series Impedance Bridge. The instrument can be utilized as a generator-detector on specialized bridge circuits. It is a handy general purpose laboratory fixed frequency audio generator, and the null amplifier is frequently useful for replacing a high sensitive oscilloscope as a null indicator. The DC power supply is useful in applications where it is desired to supply a voltage which is isolated from ground.

TABLE 1

TROUBLE SHOOTING CHART

POWER SUPPLY

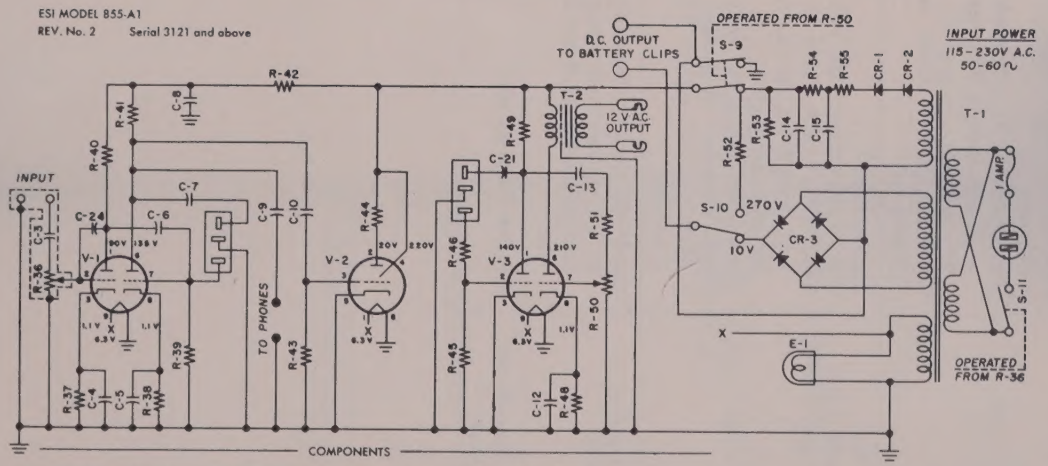
Symptom	*Probable Cause*	*Remedy*
Power indicator lamp fails to light	No AC line voltage	Trace failure in AC power source
	Null-amplifier gain control knob is not positioned correctly	Reset control knob so white dot is at OFF when control shaft is at extreme left position.
	Fuse defective	Replace with 1 amp fuse
	Power indicator lamp burned out	Replace with No. 47 bulb
	AC power switch defective	Check and replace if necessary
	Power cable defective	Repair or replace cable
	Power transformer defective	Check for continuity of filament winding; replace transformer if necessary
Line fuse blows instantly when power switch is turned ON	Defective filter capacitors	Check capacitors C-14 & C-15 for possible short to ground; replace if necessary
	Defective selenium rectifier	Check all rectifiers for possible short to ground; replace if necessary
	Power transformer defective	Check windings for possible short circuit; replace if necessary
Some tube filaments fail to light	Tubes defective	Check continuity of filaments; replace defective units
	Broken filament lead	Check circuit continuity and repair if necessary
Failure to receive DC voltage at output terminals	Wrong switching arrangement used	Recheck switch positions
	Defective switches	Check switch continuities; replace if necessary
Failure to receive 10 volts (DC) at output terminals	Defective selenium rectifier (CR-3)	Check forward & back resistance of rectifier; replace if necessary
	Defective 10 volt transformer winding	Check continuity of 10 volt winding; replace transformer if necessary
Failure to receive 270 volts (DC) at output terminals	Defective filter capacitors	Check capacitors C-14 & C-15 for possible short circuit to ground; replace if necessary
	Defective selenium rectifiers (CR-1 & CR-2)	Check forward & back resistance of rectifiers; replace if necessary
	Open transformer winding	Check continuity of high voltage transformer winding; replace transformer if necessary

NULL AMPLIFIER

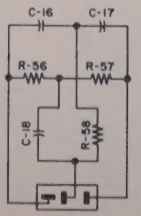
Symptom	*Probable Cause*	*Remedy*
Failure to see GREEN target on visual null indicator	No plate or target voltage	Check power supply; see above
Failure to see null signal on visual null indicator	Null amplifier defective	Plug headphones in pin jacks & listen for amplifier signal; if none, see below
	Defective tube	Replace 6U5
	Defective input cable	Check continuity of all leads including shield, repair as found necessary
	Defective bridge circuit	Check all circuits associated with instrument; correct as necessary
Input signal is not amplified	Defective amplifier tube	Replace 12AX7
	No plate voltage	Check associated circuits for open resistors (R40, 41, 42) or short circuited capacitor (C-6, 8, or 24); replace any defective components
		Remove amplifier plug-in peaking unit; if amplifier resumes operation, check plug-in unit for possible short to ground
		Check power supply; see above
	Open cathode circuit	Check all cathode circuit components (R-37, 38 & C-4, 5); replace any defective components
	Defective input wiring or control potentiometer	Check input circuitry and continuity of R-36

OSCILLATOR-AMPLIFIER

Symptom	*Probable Cause*	*Remedy*
Failure to oscillate	Defective tube	Replace 12AT7
	No plate voltage	Check power supply; see above
		Check resistor R-49; replace if defective
	Defective plug-in oscillator unit	Check values of all components in plug-in unit; replace any defective ones.
		Check for possible shorts in plug-in unit
Failure to amplify oscillator signal	Defective tube	Replace 12AT7
	Open cathode circuit	Check R-48; replace if defective
	Defective input circuit	Check R-51, C-13 & control potentiometer R-50; replace any defective component
	No plate voltage	Check power supply; see above
		Check continuity of primary winding of T-2; replace T-2 if necessary
No output signal	Defective coupling transformer	Check continuity of secondary of T-2, & associated wiring; replace transformer if necessary
Output signal off frequency	Oscillator network out of adjustment	Readjust C-23; see text



C-3	0.1 mfd. 400 vdcw	C-22	2000 mmfd. ±1% mica	R-54	2,200 Ohms, ½ W
C-4	5 mfd. 50 vdcw	C-23	100-500 mmfd. mica trimmer	R-55	100 Ohms, ½ W
C-5	5 mfd. 50 vdcw	C-24	7.5 mmfd. ±20%	R-56	167,000 Ohms, ±1%, ½ W
C-6	0.01 mfd. 400 vdcw	R-36	100,000 Ohms potentiometer	R-57	167,000 Ohms, ±1%, ½ W
C-7	0.01 mfd. 400 vdcw	R-37	4,700 Ohms ½ W	R-58	70,000 Ohms, ±1%, ½ W
C-8	0.1 mfd. 400 vdcw	R-38	1,500 Ohms ½ W	R-59	172,000 Ohms, ±1%, ½ W
C-9	0.01 mfd. 400 vdcw	R-39	1.2 Megohms, ½ W	R-60	172,000 Ohms, ±1%, ½ W
C-10	0.001 mfd. 400 vdcw	R-40	0.47 Megohms, ½ W	R-61	58,000 Ohms, ±1%, ½ W
C-12	5 mfd. 50 vdcw	R-41	0.1 Megohms, ½ W	S-9	OSC-DC switch
C-13	0.01 mfd. 400 vdcw	R-42	10,000 Ohms, ½ W	S-10	HIGH-LOW DC switch
C-14 and C-15	20-20 mfd. 450 vdcw	R-43	2.7 Megohms, ½ W	S-11	Power switch
		R-44	1.2 Megohms, ½ W	T-1	Power transformer
		R-45	2.7 Megohms, ½ W	T-2	Coupling transformer
C-16	1000 mmfd. ±1% mica	R-46	100 Ohms, ½ W	V-1	12AX7
C-17	1000 mmfd. ±1% mica	R-48	820 Ohms, ½ W	V-2	6U5
C-18	2100 mmfd. ±1% mica	R-49	22,000 Ohms, 1 W	V-3	12AT7
C-19	1000 mmfd. ±1% mica	R-50	100,000 Ohms, potentiometer	CR-1	20 ma., 130 volt selenium rectifier
C-20	1000 mmfd. ±1% mica	R-51	1.5 Megohms, ½ W	CR-2	20 ma., 130 volt selenium rectifier
C-21	0.1 mfd. 400 vdcw	R-52	22,000 Ohms, 2 W	CR-3	150 ma., 25 volt selenium rectifier
		R-53	0.1 Megohms, 1 W	E-1	# 47 pilot lamp



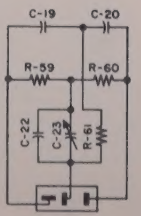


Figure 4. *Schematic diagram of Model 855-A1 Oscillator-Amplifier.*

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